CLAIMS

1. A process for growing a more uniform crystal by bottom seeding comprising,

a) loading a vessel in its lower portion with a seed crystal,

b) adding a precursor charge thereon in said vessel,

c) heating said charge to a molten state, to form a melt,

d) electromagnetically stirring said melt to form a more uniform composition melt over said seed crystal and

e) slowly reducing the temperature of said melt over said seed to grow said crystal.

2. The process of claim 1 wherein a vertical magnetic field is induced in said vessel and an electric field is applied orthogonally to said magnetic field in such a manner that a rotational stirring of the melt results.

3. The method of claim 2 comprising,

a) loading a vessel in its lower portion with a seed crystal; said vessel having electrically conductive walls or if not, an annular sleeve that closely fits within said walls, which sleeve is conductive to define an outer electrode,

b) loading a charge on said seed crystal within said vessel,

c) mounting an elongated inner electrode centrally, or nearly so, within said outer electrode, so it extends to said charge but does not contact said crystal,

d) positioning an inductance coil around said vessel,

e) heating the so loaded charge to a molten state or melt,

f) applying a voltage across said two electrodes so as to impose an electric current in said melt and

g) applying a voltage across said coil to induce a magnetic field in said melt to produce a stirring force therein to improve the uniformity of melt and crystal.

4. The process of claim 3 wherein the vessel and its contents are heated in such a manner that the temperature of said charge increases from bottom to top of said charge so that all of the melt and a small portion of the seed become molten.

5. The process of claim 3 wherein said inductance coil also serves to heat said charge to said molten state, which coil also serves to generate said magnetic field and stirring forces in said melt.

6. The process of claim 3 wherein the temperature of melt in the vessel is slowly reduced to grow said crystal at the melt-crystal interface.

7. The process of claim 6 wherein said elongated electrode is raised in advance of the rising crystal growth in said vessel.

8. The process of claim 3 wherein when said vessel is not electrically conducting, a thin wall cylinder of conducting material or one or more small diameter electrodes can be placed in the vessel near the periphery of the melt.

9.. The method of claim 1 comprising,

a) loading a vessel in its lower portion with a seed crystal, said vessel having electrically conductive walls or if not, an annular sleeve that closely fits within said walls, which sleeve is conductive, to define an outer electrode,

b) loading a lower charge on said seed crystal within said vessel to supply a lower melt,

c) lowering an inner heater in a heater housing in said vessel, onto said lower charge, which heater housing is sized to leave one or more annular spaces between it and the vessel interior walls,

d) mounting an elongated inner electrode centrally, or nearly so, within said outer electrode, so it extends through said heater housing and into said charge but does not contact said seed crystal,

e) loading an upper charge into an upper reservoir of said vessel to supply an upper melt where it can flow down through said annular spaces and around said heater housing to contact said lower melt and thus submerge a portion of said housing in said melt,

f) applying heat from the sides and from below said vessel and said seed crystal and from the inner heater above the melt, to render said upper and lower charges molten, to form said upper and lower melts and to render a portion of said seed crystal molten proximate said lower melt,

g) positioning a solenoid around said vessel,

h) applying a voltage across said two electrodes so as to impose an electric current in said lower melt and

i) applying a voltage across said solenoid to induce a magnetic field in said melt to produce a stirring force therein to improve the uniformity of melt and crystal.

10. The process of claim 9 further comprising,

a) ramping down the temperature below said vessel and seed crystal and slowly raising said inner heater and its heater housing in advance of crystal growth below, in the bestirred lower melt, to provide a more uniform radial composition both in said melt and crystal while

b) replenishing said lower melt from the upper reservoir melt through said annular spaces.

11. An apparatus for bottom seeding crystal growth comprising,

a) a vessel for holding seed crystal therein with precursor charge or melt thereon,

b) means for installing said seed crystal and said charge in said vessel,

c) a small inner elongated electrode mounted within said vessel at or near the vertical axis thereof, which electrode extends into said charge or melt but does not contact said crystal,

d) an outer electrode which extends at least partially around said inner electrode, and proximate the inner walls of said vessel,

e) heater means to heat said charge to a molten state to form a melt,

f) means for applying a voltage across said electrodes to generate a radial current in said melt,

g) an induction coil mounted around the vessel and

h) means for applying voltage to said coil to impose a magnetic field in said melt and to impart a stirring force to said melt for greater uniformity in melt and crystal.

12. The apparatus of claim 11 wherein said vessel walls serve as said outer electrode.

13. The apparatus of claim 11 wherein said coil serves as said heater means and said induction coil.

14. The apparatus of claim 11 wherein said small electrode is mounted in a heater housing, which housing is sized to leave one or more annular spaces between it and the inner walls of said outer electrode, said housing having an inside heater near the inside bottom surface of said housing, means for lowering said housing so it sits on said charge in a lower portion of said vessel, means to activate said inside heater to heat said charge to a lower melt, a reservoir

mounted in the upper portion of the vessel for holding an upper charge to supply an upper melt which can flow down through said annular spaces and around said heater housing to contact said lower melt and thus submerge a portion of said housing in said melt, means to heat said upper charge to said upper melt and means for applying voltage to said electrodes and said induction coil to impart a stirring force to said lower melt for greater uniformity in melt and crystal.

15. The apparatus of claim 14 having means to ramp down the heat applied to said lower melt and means to slowly raise said inner heater and heater housing in advance of crystal growth below, in the bestirred lower melt, to provide a more uniform radial composition both in said melt and crystal while replenishing said lower melt from said upper melt through said annular spaces.

16. A more uniform semiconductor crystal comprising one made by,

a) loading a vessel in its lower portion with a seed crystal,

b) adding a precursor charge thereon in said vessel,

c) heating said charge to a molten state, to form a melt,

d) electromagnetically stirring said melt to form a more uniform composition melt over said seed crystal and

f) slowly reducing the temperature of said melt over said seed to grow said crystal.

17. The crystal of claim 16 wherein a vertical magnetic field is induced in said vessel and an electric field is applied orthogonally to said magnetic field in such a manner that a rotational stirring of the melt results.